MASTER OF SCIENCE
IN
ELECTRICAL ENGINEERING

ANALYSIS AND SIMULATION OF THE ADVANCED AMPHIBIOUS ASSAULT VEHICLE (AAAV) ELECTRICAL SYSTEM ARCHITECTURE
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The Advanced Amphibious Assault Vehicle (AAAV) is a high water speed amphibious armored personnel carrier that will replace the current family of Marine Corps amphibious assault vehicles. The AAAV is currently in Phase I of the DOD Acquisition Process. During this phase-extensive development, testing is being conducted and prototypes are being constructed. Ongoing tests of the current electrical system architecture are revealing problems and issues that need to be addressed. Present testing is also revealing the need for a troubleshooting tool that can be used to simulate and test proposed solutions.

A distributive computing effort is being conducted with Purdue University in order to provide the Marine Corps a tool where by it can test and evaluate the entire AAAV electrical system architecture. This document provides a general system description of the AAAV, an electrical system architecture overview, and a candidate electrical system description. Testing, modeling, and computer simulation efforts applied to the NBC (Nuclear, Biological, and Chemical) fan/filter motor drive and battery banks are described and the resulting data analyzed. Current research is investigating an issue regarding energy being forced back into the high power distribution bus due to regeneration from sudden impacts on the vehicle turret. An ultra capacitor bank may be incorporated in the AAAV electrical system in an effort to mitigate the effect of this regenerative energy. Therefore, testing, modeling, and computer simulation of an ultra capacitor is also reported.

DoD KEY TECHNOLOGY AREAS: Ground Vehicles, Modeling and Simulation

KEYWORDS: Advanced Amphibious Assault Vehicle (AAAV), ACSL, Simulation, Brushless DC Machine, Distributed Computing, Ultra-Capacitor

DOSE RATE RESPONSE OF COMMERCIAL-OFF-TE-SHELF RADIATION-HARDENED POWER MOSFETS AND SCHOTTKY DIODES
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The off-state, dose rate response of several commerical-off-the-shelf radiation-hardened power MOSFETs manufactured by two corporations are reported over a wide range of operating voltages and dose rates. Data are presented for n-channel devices having different die sizes and devices having different rated breakdown voltages. The prompt photocurrent response of each MOSFET was recorded during exposure to a 20-ns radiation pulse of electrons from a linear accelerator at dose rates ranging from 1e8 Rad(Si)/s to 4e11 Rad(Si)/s. Tabulated agreement up to dose rates of 1e10 Rad(Si)/s. Burnout was observed during the

radiation pulse or shortly thereafter. The transient responses of several reverse-biased power Schottky diodes are also reported at similar dose rates. The experimentally measured photocurrent is found to be lower than anticipated. At high beam intensities on the order of $1x10^{11}$ Rad(Si)/s, several of the Schottky diodes are shown to exhibit catastrophic failure. Raw data waveforms of a power MOSFET are documented illustrating variations in the photocurrent pulses and failure modes.

DoD KEY TECHNOLOGY AREA: Radiation and Dose Rate Testing

KEYWORDS: Photocurrent, Dose Rate, Schottky

COMPUTER NETWORK PROTOCOL ANALYSIS (U)

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Abstract is classified.

DoD KEY TECHNOLOGY AREAS: Computers and Software, Other (Cyber Warfare)

KEYWORDS: Signals Intelligence, Protocol Analysis, Internet Telephony, Voice Over IP

EFFECTS OF SHIPBOARD COMPARTMENT FUEL FIRE AND FIRE EXTINGUISHING ON RF SIGNAL PROPAGATION IN THE 2.4 GHz ISM BAND

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The objective of this research was to quantify the effects of fuel fire and the follow-on fire extinguishing actions on wireless shipboard communications in the 2.4 GHz ISM band. Directional and non-directional antennas with horizontal and vertical polarization, and a PC-controlled scalar network analyzer, were used onboard ex-USS SHADWELL to measure the attenuation of 2.4 - 2.485 GHz signals transmitted through diesel and heptane fire, water mist created by the fire extinguishing system, and subsequently developed steam. A MATLAB code has been used to analyze the data statistically.

The attenuation for directional antennas exhibits relatively small variations with time and frequency, but fire and the follow-on fire-extinguishing phases create severe non-stationary frequency selective fading for non-directional antennas. Therefore standard communication techniques effective against frequency selective fading (non-stationary but slowly varying with time) are recommended for use with communication systems intended for shipboard indoors use. Even in normal conditions, without fire, water mist, or steam, we have determined that frequency selective fading would be a problem for non-directional antennas used in shipboard compartments and thus a system with anti-fading capability should be considered for shipboard use.

DoD KEY TECHNOLOGY AREA: Other (Shipboard Wireless Communications)

KEYWORDS: Instrumentation Scientific Medical (ISM) Band, Radio Frequency (RF) Propagation, Attenuation, Fire Extinguishing System, Plasma, MATLAB

DESIGN OF A LOW POWER EMBEDDED MICROPROCESSOR FOR A HANDS-EYES-EARS-FREE PERSONAL NAVIGATION AND COMMUNICATION SYSTEM

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This thesis details the engineering design of a personal, computer-based system, which is intended to support a hands-eyes-ears-free Personal Navigational and Communication System (PNCS). This computer-based system is designed to be used with COTS devices, such as, (1) a GPS receiver, (2) a laptop or desktop computer, (3) a rechargeable, long-life battery pack, and (4) a wearable tactile communications vest. The vest is currently under development by the Naval Aerospace Medical Research Lab (NAMRL) and together with this computer-based system can provide a complete hands-free personal navigational and communication system. The intent of the navigation system is to satisfy both commercial and military uses for land-based pedestrian and vehicular travel.

DoD KEY TECHNOLOGY AREAS: Biomedical, Clothing, Textiles and Food, Command, Control, and Communications, Computing and Software, Electronics, Human Systems Interface, Sensors

KEYWORDS: GPS, Navigation, Embedded Design, Low Power, Microprocessor, Tactor

GENERATION OF GLOBAL SYSTEM FOR MOBILE (GSM) SIGNALS AND THEIR TIME DIFFERENCE OF ARRIVAL (TDOA) ESTIMATION

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Emitter localization is a very important communications tool that will be extremely valuable to a multitude of different military as well as civilian applications. In many parts of the world, GSM is the preferred method of modulation used in mobile phone traffic. This thesis addresses the time difference of arrival estimation applied to GSM type signals using wavelet-based techniques. Signals are generated using the Hewlett-Packard Advanced Design System software and processed using algorithms based on Matlab. The results of this thesis prove improvement can be made upon the localization of a GSM emitter through the use of wavelet-based denoising techniques.

DoD KEY TECHNOLOGY AREA: Other (Emitter Localization)

KEYWORDS: Global System for Mobile, Time Difference of Arrival, Wavelet Denoising, Emitter Localization

AN INVESTIGATION AND ASSESSMENT OF LINUX IPCHAINS AND ITS VULNERABILITIES WITH RESPECT TO NETWORK SECURITY

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This research thesis formulates a survey of network security and IPChains, the Linux firewall. It provides a detailed description of prominent network security procedures in use today. This paper falls directly in line with the goals of Executive Order 13010, the President's Critical Infrastructure Protection Plan, supports the goals of the National Security Agency's SIGINT Business Plan and the goals of both the Unified and Maritime Cryptologic Architecture. It will aid in the development of the problem solving efforts of the national cryptologic organization and be used to provide critical intelligence support to the Operational command and the national intelligence community.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Information Warfare, Command, Control and Communications

KEYWORDS: Linux, Network Security, IPChains

DESIGN AND IMPLEMENTATION OF A HUMAN PRESENCE DETECTION SENSOR FOR USE WITH AUTONOMOUS MOBILE ROBOTS

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This thesis investigates the feasibility of designing a human presence detection sensor for implementation with an autonomous mobile robot. Current technology does not offer a low cost and readily realizable method for an autonomous vehicle to accurately identify the presence of human beings. Cameras, which require high-level image processing, have proven effective in identifying human faces. However, this sensing system would cost more than the autonomous mobile robots themselves, rendering the system cost inefficient. Also, active multi-array microwave systems and passive infrared systems have proven to be competent motion detection sensors, but not human presence detectors.

In this thesis, a type of sensor to identify an inherent commonality among all humans, infrared energy, is explored as well as a method of extracting this commonality from the rest of the environment. Finally, a proof of concept system is developed in various environments. Testing results demonstrate that a low-cost, high-performance human detection and tracking system for use with mobile robots is achievable using infrared sensors and digital signal processing. Additionally, recommendations are provided to enhance the current design using a more capable micro-controller for future system improvements. This thesis work is the first part of an ongoing project that implements a presence sensor that allows a mobile robot to identify and follow a human being.

DoD KEY TECHNOLOGY AREA: Sensors

KEYWORDS: Infrared, Motion Detector, Presence Sensor

IMPLEMENTATION OF A FAULT TOLERANT COMPUTING TESTBED: A TOOL FOR THE ANALYSIS OF HARDWARE AND SOFTWARE FAULT HANDLING TECHNIQUES

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With spacecraft designs placing more emphasis on reduced cost, faster design time, and higher performance, it is easy to understand why more commercial-off-the-shelf (COTS) devices are being used in space based applications. The COTS devices offer spacecraft designers shorter design-to-orbit times, lower system costs, orders of magnitude better performance, and a much better software availability than their radiation hardened (radhard) counterparts. The major drawback to using COTS devices in space is their increased susceptibility to the effects of radiation, single event upsets (SEUs) in particular.

This thesis will focus on the implementation of a fault tolerant computer system. The hardware design presented here has two different benefits. First, the system can act as a software testbed, which allows testing of software fault tolerant techniques in the presence of radiation induced SEUs. This allows the testing of the software algorithms in the environment they were designed to operate in without the expense of being placed in orbit. Additionally, the design can be used as a hybrid fault tolerant computer system. By combining the masking ability of the hardware with supporting software, the system can mask out and reset processor errors in real time. The design layout will be presented using OrCAD® schematics.

DoD KEY TECHNOLOGY AREAS: Space Vehicles, Computing and Software, Electronics

KEYWORDS: Fault Tolerant Computing, Triple Modular Redundancy (TMR), Commercial-off-the-Shelf (COTS) Devices, Single Event Upsets (SEU)